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MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: AN/PSN-11 Precision Lightweight GPS Receiver (PLGR) White Paper

1. Over the past several months, USAFAS has received numerous inquiries pertaining to the use of the PLGR for artillery positioning. The enclosed white paper is furnished in response to these field inquiries.
2. The AN/PSN-11 is approved for the use of artillery positioning when users are properly trained to use the PLGR in accordance with TM 11-5825-291-13, and the safety and training guidelines set forth in this white paper.
3. POC at USAFAS is CW03 Barnes or SFC Jones, Survey Branch, Gunnery Department, DSN 639-2805/6616.

Encl
as

//Original Signed//
TONEY STRICKLIN
Major General, USA
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AN/PSN-11 PRECISION LIGHTWEIGHT GPS RECEIVER (PLGR)
USED FOR
ARTILLERY POSITIONING

1. PURPOSE. The purpose of this paper is to approve the Precision Lightweight GPS Receiver AN/PSN-11 (PLGR) as a method of determining coordinates and height for live firing artillery positions. When discussing artillery-positioning data, three elements are included. These elements are orientation, coordinates, and height. If any of the three elements are not established accurately enough to meet current accuracy specifications, the position is considered a hasty position. As a stand alone piece of equipment the PLGR cannot establish azimuth, however, it can provide the coordinates and height needed to initialize and update the Gun Laying Positioning System (GLPS), and the MLRS's and Paladin's on board Inertial Navigation systems.

2. DISCUSSION. This paper addresses the use of the AN/PSN-11 GPS Receiver. Earlier models of GPS receivers such as the AN/PSN-8, 9, and 10 are not addressed in this paper and therefore may not be used to determine position location.

a. GPS AND PLGR. GPS is a space-based navigation system which provides world-wide, continuous, all weather, three-dimensional position information. The GPS system consists of three primary segments. First, the space segment, which is the satellite constellation. The space segment is complete, insuring world-wide coverage with a minimum of four satellites in view at all times. The PLGR must be able to acquire at least four satellites before a three-dimensional position can be determined. Second, the control segment which consists of monitoring stations and master control stations which are in place and operational. Third, the ground segment which encompasses all user receivers. Currently, the primary receiver being issued for ground forces is the AN/PSN-11 (PLGR). This PLGR can achieve the accuracies needed for cannon artillery as outlined in the current Standardization Agreements (STANAG) and the artillery Position and Navigation (POS/NAV) plan.

b. GPS accuracy requirements are expressed in terms of Probable Error (PE), and Circular Error Probable (CEP). PE is a value which is exceeded as often as it is not, i.e. it has a 50 percent probability of occurrence. CEP is the radius of a circle, centered about the true position, such that any measured or calculated position has a 50 percent probability of lying within that circle.

ACCURACY FOR THE PLGR IS:

Horizontal:	10 meters Circular Error Probable (CEP)
Altitude:	10 meters Probable Error (PE)

c. ARTILLERY POSITIONING REQUIREMENTS. Current STANAGS stipulate the standard position accuracy requirements for cannon artillery, rockets, and target acquisition assets. These are shown below in figure 1.

SYSTEM	HORIZONTAL POSITION (M) CEP (50%)	VERTICAL POSITION (M) PE (50%)	DIRECTION (MILS) PE (50%)
105T How	17.5	10	0.4
155T How	17.5	10	0.4
155SP How	17.5	10	0.4
MLRS	8	3.6	1
BFIST/Striker	30	20	2
Q-36	10	10	0.4
Q-37/Q-47	10	10	0.4
Q-25A/Q-58	43.7	10	3
MMS	114	10	9

Figure 1

d. SURVEY vs. PLGR. The Positioning Azimuth Determining System (PADS) has been the mainstay of field artillery survey for the last 15 years, however, due to its age the PADS has become difficult and expensive to maintain. Therefore, PLGR merged with inertial navigation systems have been fielded to provide alternatives for commanders in the event that their survey assets are unavailable. These systems can be used to provide positioning and orientation and are designed to complement one another, not just when survey assets are unavailable. There are different accuracies associated with Survey Control Points (SCPs) for MLRS and required accuracies for firing. Based on both system accuracies of PADS and PLGR and the required accuracies established position control at SCPs and Firing Points (FPs), the PADS is currently the only means to establish position control at SCPs. The PLGR can be used to establish position control if the data is entered during an update at the FP from which the launcher will fire. With all other weapon systems it is up to the Commander as to determine which system to use based on METT-T. The following systems are authorized for use:

- (1) MODULAR AZIMUTH POSITIONING SYSTEM (MAPS)& HYBRID (MAPS/H)
- (2) POSITION AND AZIMUTH DETERMINING SYSTEM (PADS)
- (3) PRECISION LIGHTWEIGHT GPS RECEIVER (PLGR)
- (4) IMPROVED STABILIZATION REFERENCE PACKAGE (ISRP)
- (5) GUN LAYING AND POSITIONING SYSTEM (GLPS)
- (6) POSITIONING AND NAVIGATION UNIT (PNU)
- (7) BFIST/STRIKER EQUIPMENT MISSION PACKAGE (EMP)

3. SAFETY AND TRAINING. As with all artillery procedures, safety and proper checks are a critical issue. The following checks and safety procedures must be used with the PLGR.

WARNING

Azimuth determined with the PLGR is for navigation only. The PLGR azimuth is not accurate enough for artillery orientation and should never be used for this purpose. Observations at Fort Sill demonstrated azimuth inaccuracies that were very erratic. Azimuth errors ranging from 0.7 mils to 50 mils have occurred.

a. Verify PLGR setup.

(1) **Crypto.** The proper crypto keys must be loaded before the PLGR will function using the Precise Positioning System (PPS). Recently the President ordered that Selective Availability (SA) be turned off. The rationale was to improve the accuracy available to civil users. This benefits many commercial GPS applications, including air, road, marine and rail navigation, telecommunications, and emergency responses. Note that these are all peacetime activities. Second, and more important to the military user, the President's statement made clear that the Department of Defense retains the ability to selectively deny GPS signals on a regional basis when our national security is threatened. This means it is more critical than ever that military users only operate with PPS-rated receivers capable of operating under intentional signal degradation and other forms of hostile interference. So while the President's policy change improves the efficiency of commercial GPS, it does not mean that military users can use commercial GPS systems, which do not operate with a crypto fill.

(2) **Datum.** Map datum should be the same as the operational datum. If not, significant position errors relative to the operational data are possible.

(3) **Coordinates.** The UTM coordinate format will normally be the preferred selection since UTM is used by survey and most fire control systems.

(4) **Elevation.** Mean sea level is the normal selection. Most military maps refer elevation to mean sea level. Elevation hold mode is used to increase the accuracy of the PLGR when elevation is poor, such as:

(a) When only three satellites are available due to poor satellite geometry, reduced satellite availability, or line of site blockage of satellite signals due to terrain, vegetation, buildings, vehicles, or other obstructions.

(b) When at least four satellites are available but poor geometry exists. For more information on elevation hold mode see TM 11-5825-291-13.

(5) **Units of measurement.** Meters are the normal selection. Most military maps refer to distance and elevation in meters.

b. **Figure of Merit (FOM).** FOM is accuracy estimation displayed by the PLGR, which ranges from one through nine. A FOM 1 is the best accuracy

estimation displayed by the system. When artillery positions are determined, only coordinates obtained when FOM 1 is displayed will be considered for use.

c. **Mode of Operation.** The PLGR offers Fix, Continuous, Averaging, and several other modes of operation. The averaging mode yields the most accurate data and is the only method to be used when determining a position for indirect fire weapons. The PLGR should achieve a minimum amount of averaging hits of 200 before the location and elevation from a PLGR is accepted. In this mode the receiver must not be moved.

d. **Verify Position.** Position verification to check for unacceptable errors must always be done prior to firing. The following are possible methods to the verification requirement:

(1) Use a two-person check on the PLGR data by using two different PLGRs to independently determine the position data.

(2) Use resection or graphic resection if identifiable points are visible.

(3) In identifiable terrain, a map spot is the minimum acceptable verification and should be conducted along with all other means of verification.

e. **Verify Satellite Signal Strength.** On the fourth page of the Status screen validate the satellite signal strength to ensure that it is between 25 to 50 dB. The Fort Sill Survey Branch has demonstrated that the PLGR can take several minutes while it is being jammed before the FOM value drops below 1. During that time bad position data may be received.